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Review

Educational interventions promoting evidence-based practice among emergency nurses: A systematic review

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ABSTRACT

Introduction: Emergency nurses are expected to adopt evidence-based practice (EBP). The aim of this systematic review was to describe educational interventions promoting EBP and their outcomes among emergency nurses, compared with no education, to inform clinicians and researchers about effective educational interventions suitable for use in emergency departments (EDs).

Methods: CINAHL, Cochrane, PubMed and Scopus were systematically searched to identify studies published between January 1, 2006 and October 20, 2016 describing educational interventions designed to promote EBP among emergency nurses. 711 studies were identified and screened; 10 were selected for inclusion and quality assessment. The studies were analyzed using deductive content analysis, and the review's results are presented in accordance with the PRISMA guidelines.

Results: Ten relevant studies on nine different self-developed educational interventions were identified. Eight studies had highly significant or significant results. Interventions involving face-to-face contact led to significant or highly significant effects on patient benefits and emergency nurses' knowledge, skills, and behavior. Interventions using written self-directed learning material led to significant improvements in nurses' knowledge of EBP. All the descriptions of the interventions were incomplete, and the reported details varied considerably between the studies.

Conclusions: There have been few studies on educational interventions to promote EBP among emergency nurses but the available results are promising.

1. Introduction

Because of the dynamic nature of the clinical environment, emergency nurses are expected to keep pace with advances in research and ensure that their practice is evidence-based. Little is known about how evidence-based practice (EBP) is integrated within emergency nurses' practice. However, two qualitative studies have revealed potential challenges. Bigham and colleagues [1] studied (n = 176) barriers that delayed the adoption of practices for improving survival rates after out-of-hospital cardiac arrest based on guidelines published by the American Heart Association. The barriers they identified included instruction delays, delays related to reprogramming defibrillators, and barriers related to decision-making in agencies. Based on a separate study (n = 34), Person et al. [2] argued that development and training opportunities are needed to promote safer and more efficient patient care

in emergency departments.

Evidence-based practice (EBP) is widely accepted as a core component of professional education for health professionals [3]. EBP is defined as an approach to solving problems in clinical decision-making that integrates the best evidence from robust studies, clinicians' expertise, and patients' values and preferences [4]. EBP has gained global currency as a decision-making paradigm, and growing numbers of studies have explored educational interventions intended to increase knowledge of EBP and related skills [5,6].

Integrating evidence into daily clinical practice and decision-making has been more challenging than initially expected. Challenges to the implementation of EBP include time limitations, inadequate EBP knowledge or education, organizational resistance, heavy workloads, resistance from nursing colleagues, uncertainty about where to find information and how to critically appraise evidence, limited access to

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resources that facilitate EBP, and a paucity of robust studies on the effectiveness of EBP interventions in nursing practice. [4,7]

To our knowledge, there have been no systematic reviews on the effectiveness of educational interventions promoting EBP among emergency nurses. The aim of this systematic review was to describe educational interventions promoting EBP and their outcomes among emergency nurses, compared with no education. The review is intended to inform clinicians and researchers about effective educational interventions suitable for use in emergency departments (EDs). The research questions were:

1. What kind of educational interventions have been used to promote EBP in emergency nursing?
2. What outcomes have been achieved by using educational interventions promoting EBP in emergency nursing?

2. Methods

This systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement guidelines for reporting study methods and results [8].

2.1. Search strategy

A systematic literature search of the CINAHL, Cochrane, PubMed/MEDLINE (Ovid), and Scopus databases was performed in October 2016 with the expert assistance of a university librarian. The search used appropriate subject headings and/or keywords (Table 1), and was limited to publications in English published between January 1, 2006 and October 20, 2016. Fig. 1 illustrates the search and selection processes.

2.2. Study selection

The inclusion criteria were: (1) the study's participants were emergency nurses working in ED, (2) the study examined an educational intervention intended to promote EBP, (3) the report included an evaluation of the intervention's patient- and/or staff-related outcomes, (4) the study was published in a peer-reviewed scientific journal, and (5) the reported results originated from a randomized controlled study, a quasi-experimental study with a comparison group, or an uncontrolled quasi-experimental study. Exclusion criteria were: (1) the report did not describe an educational intervention to promote EBP, (2) the study was non-empirical, and (3) the participants were not emergency nurses.

Table 1
Search terms used in databases.

Database	Search terms
Cinahl	<i>Headings:</i> (Boolean phrase): (MH "Emergency Nursing") OR (MH "Emergency Nurse Practitioners") AND (MH "Nursing Practice, Evidence-Based") OR (MH "Professional Practice, Evidence-Based") OR (MH "Nursing Practice, Theory-Based") OR (MH "Nursing Practice, Research-Based") OR (MH "Education, Nursing, Theory-Based") OR (MH "Education, Nursing, Research-Based") AND (MH "Quality of Health Care") OR (MH "Quality Management, Organizational") OR (MH "Quality Improvement") OR (MH "Quality Assessment") OR (MH "Quality of Nursing Care") OR "knowledge translation" OR (MH "Professional Development"). <i>Keywords:</i> (((("evidence based practice" OR "evidence based nursing" OR "knowledge translation") AND (("emergency nurse*" OR ("emergency department*" AND nurse*)))) AND ((educ* OR train* OR "quality improvement"))).
Cochrane Library	<i>Headings and keywords:</i> "Evidence based practice" OR "Evidence based nursing" OR "Knowledge translation" AND "Emergency department" AND "Nurs*" AND "Educ" OR "Train*" OR "Quality improvement*".
PubMed	<i>Headings:</i> "Professional Competence"[Mesh] OR "Outcome Assessment (Health Care)"[Mesh] OR "Evidence-Based Emergency Medicine"[Mesh] OR "Evidence-Based Nursing"[Mesh] OR "Evidence-Based Practice"[Mesh] OR "Quality Improvement"[Mesh] AND "Emergency Nursing"[Mesh]. <i>Keywords:</i> (((("evidence based practice" OR "evidence based nursing" OR "knowledge translation") AND (("emergency nurse*" OR ("emergency department*" AND nurse*)))) AND ((educ* OR train* OR "quality improvement"))).
Scopus	<i>Keywords:</i> (((TITLE-ABS-KEY ("Evidence based practice") AND DOCTYPE (ar OR re) AND PUBYEAR > 2005) OR (TITLE-ABS-KEY ("Evidence based nursing") AND DOCTYPE (ar OR re) AND PUBYEAR > 2005) OR (TITLE-ABS-KEY ("Knowledge translation") AND DOCTYPE (ar OR re) AND PUBYEAR > 2005)) AND (((TITLE-ABS-KEY ("Emergency department") AND DOCTYPE (ar OR re) AND PUBYEAR > 2005) AND (TITLE-ABS-KEY ("Nurs*") AND DOCTYPE (ar OR re) AND PUBYEAR > 2005)) OR (TITLE-ABS-KEY ("Emergency nurse*") AND DOCTYPE (ar OR re) AND PUBYEAR > 2005)) AND ((TITLE-ABS-KEY ("Educ*") AND DOCTYPE (ar OR re) AND PUBYEAR > 2005) OR (TITLE-ABS-KEY ("Train*") AND DOCTYPE (ar OR re) AND PUBYEAR > 2005) OR (TITLE-ABS-KEY ("Quality improvement*") AND DOCTYPE (ar OR re) AND PUBYEAR > 2005))).

The systematic selection process had three phases. After rejecting 11 duplicate hits, two reviewers independently screened the eligibility of 711 potentially relevant titles, 82 abstracts, and 20 full texts based on the above criteria. Consensus on inclusion was established by discussion. Ten studies were ultimately included (Fig. 1); nine were uncontrolled quasi-experimental studies using a pre-test post-test design [9,10,12–18], and one was a quasi-experimental study with a comparison group [11]. An overview of the included studies is presented in the Supplementary material (Table S1).

2.3. Quality appraisal

The quality of the original studies was evaluated by two reviewers using the design-specific study quality assessment criteria of Gifford et al. [19]. All the evaluated studies were included in the analysis, to provide a broad and unbiased overview of current research.

2.4. Data analysis

The data were analyzed using deductive content analysis as described by Elo and Kyngäs [20]. In a deductive content analysis, a structured or unconstrained matrix of analysis is operationalized based on previous knowledge such as a theory or model. All data are coded for correspondence with the aspects of the matrix; codes that fit the matrix are chosen from the data [20]. A deductive approach was chosen because two appropriate frameworks for creating structured matrices were available.

To describe the educational interventions, a content analysis was performed using the Guideline for Reporting Evidence-based practice Educational interventions and Teaching (GREET) checklist as a framework. The GREET checklist is a specific, reliable, and valid reporting guideline designed to provide a framework for consistent and transparent reporting of educational interventions for EBP. It comprises 17 items (Table 2) that are recommended for reporting EBP educational interventions [21]. These items constituted the structure of the analysis matrix. Coding was initially done by determining whether each item was addressed in the study being reviewed; if the item was addressed, a cross was placed in the corresponding cell of Table 2. The coded results are presented in Table 2 and discussed verbally in the text.

To describe the outcomes of the educational interventions in emergency nursing, a content analysis was performed using the taxonomy of the Classification Rubric for EBP Assessment Tools in Education (CREATE) as a framework. CREATE includes seven categories (Table 3) that have been recommended to be assessed when implementing educational interventions on EBP [3]. These categories

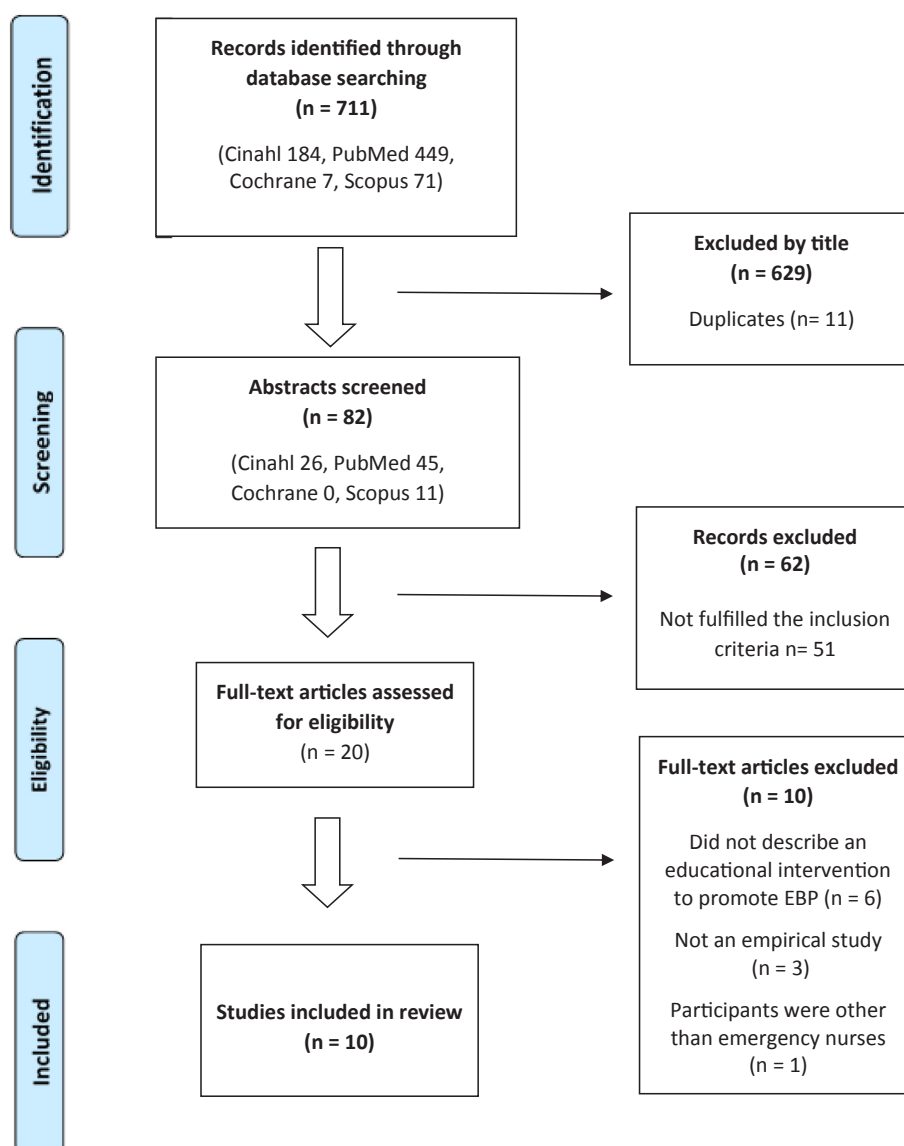


Fig. 1. Flow diagram of search and selection process.

constituted the structure of the analysis matrix. Coding was initially done by determining whether each assessment category was addressed in study under evaluation. If the category was addressed, the corresponding results from the study were analyzed. The significance of the results is presented in Table 3 and the verbal results are presented in the text.

3. Results

3.1. Included studies

Table S1 presents details of the 10 included studies, including their quality and purpose, the development and learning content of the interventions, the educational strategy used, their settings and participants, and their data collection and analysis procedures.

One study was conducted in five different hospital EDs [16] and another was conducted in four EDs [11]. Seven studies were conducted in a single hospital ED [9,10,13,14,17,18]; the tenth study's setting was not disclosed [15].

3.2. Description of the educational interventions promoting evidence-based practice in emergency nursing

The interventions promoting EBP in emergency nursing were described using the GREET checklist [21] as a framework (Table 2). None of the 10 studies described every GREET checklist items.

All 10 studies included a brief description of the educational intervention. Only one study specified the educational theory, concept or approach used in the intervention, which was based on transformative learning theory [16]. None of the studies specified the learning objectives of the learners. None of the studies clearly stated the steps of the EBP process (inquire, ask, search, appraise, integrate, evaluate, disseminate) when describing the EBP content. The contents of the interventions were based on the intended changes in clinical practice.

Educational materials were mentioned in seven studies. In two interventions, lecture notes and PowerPoint handouts were given to participants who missed lectures [9,10]. In four interventions, posters or leaflets were used to inform a wider audience about the interventions' content [12,13,17,18] and help staff remember the content [13,17]. Activity sheets were used in one intervention [11]. All studies described the educational strategies used in the intervention. Seven studies used strategies involving theory-based lectures or tutorials

Table 2
Synthesis of the GREET checklist (Phillips et al. [21]¹) items used in reporting in original studies.

The GREET checklist item/Study	9 Considine and Brennan [9]	10 Considine and Brennan [9]	11 Considine et al. [11]	12 Considine and McGillivray [12]	13 Damkhang, J. et al. [13]	14 Habich and Letizia [14]	15 Jordan and Moore Nadler [15]	16 Munroe et al. [16]	17 Salomon and Jurica 2016	18 Yeoh et al. [18]
1. INTERVENTION: Provide a brief description of the educational intervention for all groups involved [e.g. control and comparator(s)].	x	x	x	x	x	x	x	x	x	x
2. THEORY: Describe the educational theory (ies), concept or approach used in the intervention.								x		
3. LEARNING OBJECTIVES: Describe the learning objectives for all groups involved in the educational intervention.										
4. EBP CONTENT: List the foundation steps of EBP (ask, acquire, appraise, apply, assess) included in the educational intervention.										
5. MATERIALS: Describe the specific educational materials used in the educational intervention. Include materials provided to the learners and those used in the training of educational intervention providers	x	x	x	x	x				x	
6. EDUCATIONAL STRATEGIES: Describe the teaching/learning strategies (e.g. tutorials, lectures, online modules) used in the educational intervention.	x	x	x	x	x	x	x	x	x	x
7. INCENTIVES: Describe any incentives or reimbursements provided to the learners.										
8. INSTRUCTORS: For each instructor(s) involved in the educational intervention describe their professional discipline, teaching experience/ expertise. Include any specific training related to the educational intervention provided for the instructor(s).	x	x		x				x		
9. DELIVERY: Describe the modes of delivery (e.g. face-to-face, internet or independent study package) of the educational intervention. Include whether the intervention was provided individually or in a group and the ratio of learners to instructors.	x	x	x	x	x	x	x	x	x	x
10. ENVIRONMENT: Describe the relevant physical learning spaces (e.g. conference, university lecture theatre, hospital ward, community) where the teaching/learning occurred.	x	x		x		x				
11. SCHEDULE: Describe the scheduling of the educational intervention including the number of sessions, their frequency, timing and duration.	x	x	x	x		x		x		
12. Describe the amount of time learners spent in face to face contact with instructors and any designated time spent in self-directed learning activities.	x	x		x			x	x	x	
13. Did the educational intervention require specific adaptation for the learners? If yes, please describe the adaptations made for the learner(s) or group(s).										
14. Was the educational intervention modified during the course of the study? If yes, describe the changes (what, why, when, and how).										
15. ATTENDANCE: Describe the learner attendance, including how this was assessed and by whom. Describe any strategies that were used to facilitate attendance.	x	x	x		x	x			x	x

(continued on next page)

Table 2 (continued)

The GREET checklist item/Study	9 Considine and Brennan [9]	10 Considine and Brennan [9]	11 Considine et al. [11]	12 Considine and McGillivray [12]	13 Damkliang, J. et al. [13]	14 Habibich and Letizia [14]	15 Jordan and Moore Nadler [15]	16 Munroe et al. [16]	17 Salomon and Jurica 2016	18 Yeoh et al. [18]
16. Describe any processes used to determine whether the materials (item 5) and the educational strategies (item 6) used in the educational intervention were delivered as originally planned.										
17. Describe the extent to which the number of sessions, their frequency, timing and duration for the educational intervention were delivered as scheduled (item 11).										

¹ The checklist published with a permission of the authors.

Table 3

Outcome evaluations conducted in the original studies and the significance level¹ of the results.

The CREATE framework (Tilson et al. [3]) ² assessment category/Study	9 Considine and Brennan [9]	10 Considine and Brennan [9]	11 Considine et al. [11]	12 Considine and McGillivray 2010	13 Damkliang, J. et al. [12]	14 Habibich and Letizia [14]	15 Jordan and Moore Nadler [15]	16 Munroe et al. [16]	17 Salomon and Jurica 2016	18 Yeoh et al. [18]
7 Benefits to the patient		SHS	ne	*	ne	i	i	SS	i	*
6 Behaviors										
5 Skills		ne	i	SS	ne	ne	*	ne	ns	ne
		ne	ne	ne	ne	ne	i	SS	ne	ne
4 Knowledge		SHS	SHS	ne	SHS	SHS	i	ne	SS	i
3 Self-Efficacy		ne	ne	ne	ne	i	i	ne	ne	ne
2 Attitude		ne	ne	ne	ne	ne	*	ne	ne	ne
1 Reaction to the educational experience		ne	ne	ne	ne	i	*	ne	ne	i

¹ Outcome mentioned in the article but measurement results not reported (*), improvement which was not statistically significant (ns), statistically significant improvement $p < 0.05$ (SS), statistically highly significant improvement $p < 0.001$ (SHS), improvement percentage shown (i), not evaluated in the study (ne).

² The framework published with permission of the authors.

[9,10,12–15,17]. Other strategies made use of a written self-directed learning package [11], a workshop [16], and a combination of multifaceted education initiatives [18]. None of the studies described the incentives or reimbursements provided to the learners.

The instructors were briefly mentioned in four studies. The content of the tutorials was reviewed by a pediatric emergency nurse and an ED pediatrician [9,10]. The instructors were a researcher [12], ED nurse educators [12], or a team of experienced ED nurses [16]. Virtually all studies described the modes of delivery. The most common modes were theoretical lectures or tutorials, which were delivered face-to-face in groups [9,10,12–15,17] or during workshops [16]. Other delivery modes used in the interventions were a self-directed learning package [11], an e-learning module, in-service training, reminder techniques, and staff feedback [18]. Five studies specified the environment of the interventions [9,10,12,14,17], stating that they were delivered via face-to-face sessions inside the hospital environment. Another study used e-learning provided via the hospital's intranet [18].

Two studies clearly described the schedules of the educational interventions, i.e. the number and timing of tutorials, and the period over which the intervention was delivered [9,16]. The self-directed learning module was divided into five sections, but the durations of each section were not specified [11]. Three studies on tutorial-based interventions specified the duration of the tutorials but not their frequency, timing, or number of repetitions [10,12,14].

Six studies specified the amount of time learners spent in face-to-face contact with the instructor. The periods of face-to-face contact were described as brief pre-shift huddles [17], thirty- [9,10,12] or forty-minute tutorials [14], or four-hour interactive sessions [16]. None of the studies described planned or unplanned changes, i.e. adaptations or modifications. Learners' attendance was described in five studies. The attending learners were all ED nurses working in an adult and/or pediatric ED; the numbers of attendees in each intervention ranged from 14 to 88. The content of the tutorials was provided as session notes and posted on ED computers [9,10] or as a package on the hospital intranet [18]. None of the studies specified whether the materials and educational strategies were delivered as originally planned or whether the educational intervention was delivered as scheduled.

3.3. Outcomes of the educational interventions promoting evidence-based practice in emergency nursing

The outcomes of the interventions promoting EBP in emergency nursing were described using the CREATE taxonomy [3] as a framework (Table 3).

Benefits to the patient relates to the impact of EBP educational interventions on patients' care. In five studies [12,14,15,17,18], patient benefits were evaluated by auditing clinical documentation. In a sixth study, patient benefits were evaluated by performing structured telephone interviews with the patients' parents [9], revealing that after the intervention, patients received better discharge advice from ED nurses concerning fever management at home [9]. This improvement was highly statistically significant. In another study, an observation and documentation checklist and a non-technical skills scale were used to evaluate nurses' patient assessments before and after implementing a new evidence-informed nursing assessment framework HIRAIID (History, Identify Red flags, Assessment, Interventions, Diagnostics, reassessment and communication) [16]; there was a statistically significant improvement in the nurses' assessments after the intervention. Separately, patients' pain assessments during triage (measured using a pain assessment scale) improved after an intervention targeting EBP in pediatric pain assessment [18], and an intervention targeting EBP in nasal-gastric tube (NGT) insertion procedures was followed by an increase in nurses' use of evidence-based medication and understanding of patients' discomfort [17]. Finally, nurses' evaluations and documentation practices improved after an intervention targeting child maltreatment (measured using a child maltreatment screening tool)

[15].

Behavior refers to what learners actually do in practice, and was reported in four studies. It was evaluated based on participants' self-reports [9,10,12] or external observations [11]. An intervention based on EBP stroke guidelines led to improvements in triage, patient assessment, and risk management [12]. Additionally, EBP interventions relating to child fever management [10] and oxygen administration [11] led to improvements in independent or collaborative decision-making [10] and oxygen flow and nasal cannulae selection [11], respectively. One study collected data on behavioral changes but did not report the results [15]. None of these improvements was highly statistically significant.

Skills refer to the application of knowledge, ideally in a practical setting. Skills were evaluated as performance and reported in two studies [15,16]. Both tools were self-administered questionnaires asking ED nurses to self-evaluate their skills. The studies indicated statistically non-significant improvements in ED nurses' non-technical patient assessment skills [16] and identification of child maltreatment [15] after the corresponding interventions. Neither of these studies gained statistically significant improvements. Eight studies included no direct data on skill evaluations, but seven mentioned improvements in ED nurses' skills in various clinical nursing practice areas [10–12,14,16,17] without presenting supporting evidence.

Knowledge refers to the learners' retention of facts and concepts relating to EBP. Seven studies included data on self-evaluations of participants' factual knowledge. The knowledge was tied to specific clinical substance [9–11,13–15,17]. There were improvements in ED nurses' knowledge of child fever management [9,10], oxygen administration [11], care for patients with severe traumatic brain injuries [13], assessment of pediatric pain [14], identification of child maltreatment [15], and EBP in medication for NGT insertion [17]. Four of the seven studies gained highly statistically significant improvements [10,13,14,17].

Self-Efficacy refers to people's judgments of their ability to perform a given activity. ED nurses reported statistically non-significant increases in confidence (i.e. self-efficacy) in assessing children's pain [14] and identifying child maltreatment [15] after EBP interventions.

Attitudes refers to the learner's beliefs regarding the importance and usefulness of EBP in informed clinical decision-making. Data on attitudes were gathered during one study [15] but the corresponding report included no information on how the studied intervention affected the nurses' attitudes.

The learners' reaction to the educational experience is evaluated based on their opinions regarding the learning experience and the intervention's efficacy. One study [14] evaluated the learners' experiences on how the learning objectives were met and the effectiveness of computer-based learning as a method. The learners reported that the learning objectives were met to a moderate or great extent, the content was relevant, and the method was effective. Another study [15] noted that the learners found the maltreatment intervention to be beneficial. Two other studies included evaluations of the intervention by learners but these results were not reported [17,18]. None of the studies gained statistically significant improvements.

Eight of the studies had significant or highly significant outcomes. Six of them used face-to-face lectures/tutorials [9,10,12–14,18], and one used a face-to-face workshop [15] as an educational strategy and mode of delivery. Significant or highly significant effects on emergency nurses' knowledge [9,10,13,14], benefits to the patient [9,15,18], skills [16], and behavior [12] were observed after interventions involving face-to-face contact. Additionally, significant improvements in nurses' knowledge were observed after an intervention using self-directed learning material [11]. However, it was impossible to determine whether the educational strategies and modes of delivery caused these effects because the interventions included many elements, and only one of the studies [11] was controlled. Three of the ten original studies were considered to be of excellent quality.

4. Discussion

In this review, we found ten studies describing nine self-developed educational interventions to promote EBP. Use of the GREET checklist as a framework enabled consistent analysis of these educational interventions. All ten reports addressed three checklist items by providing a brief description of the studied intervention, the educational strategies that were used, and the intervention's modes of delivery. Additionally, some of the studies described the intervention's underlying educational theory, learning objectives, educational materials, instructors, environment, and schedule, as well as the amount of face-to-face contact time learners received, and/or learner attendance. It has previously been noted that educational interventions promoting EBP are often reported inconsistently and incompletely, limiting the scope for comparing, interpreting, and synthesizing the reported results. [6,22,23]

All the studies described the EBP content of the studied interventions as clinical nursing content. None of the studies described any EBP steps (inquiry, ask, search, appraise, integrate, evaluate, disseminate) [4]. Conversely, 75% of the studies included in the systematic review by Phillips et al. described at least one EBP step [6]. To support ED nurses' learning of EBP, educational interventions should be modified to include both clinical content relating to EBP and explicit discussions of the steps in the EBP process to ensure that participating nurses are adequately informed about integrating and evaluating EBP in clinical practice [3,6].

The interventions were implemented via face-to-face group sessions or over the internet using a self-learning package. However, Häggman-Laitila et al. recommend that EBP education could be implemented using at least two teaching/learning methods [23]. Clinicians responsible for selecting educational methods for ED nurses should follow this advice in future.

Multi-professional collaboration in the development or implementation of the educational intervention was only mentioned in four of the included studies. No specific multi-professional EBP educational interventions were identified despite the need for such interventions in health care [22]. We also found no studies of simulation-based EBP interventions even though simulations have been shown to support learning among emergency nurses by authors such as Kim and Gisoo [24]. Developing such interventions and investigating their effectiveness in the promotion of EBP would be important in EDs, where multi-professional collaboration is essential and simulations are used extensively to support learning.

None of the studies discussed any potential modifications or piloting of the studied intervention, whether the intervention was adapted during the study, or whether the intervention was delivered as scheduled. Pilot studies could have given the researchers opportunities to identify key uncertainties while developing the interventions, potentially increasing their feasibility [25]. Only one study used an intervention that had been developed earlier [15]. Moreover, all of the interventions were implemented only once, mainly on a local basis in a single context. Similar findings have been reported previously [22,23]. In future, efforts should be made to standardize EBP-related educational interventions in emergency nursing.

Using the CREATE taxonomy [3] to analyze the studies' outcomes strengthened the review because it is an encompassing framework that includes all aspects that should be considered when implementing educational interventions targeting EBP. The seven categories of the taxonomy were addressed to varying degrees in the included studies. It is important to use multiple methods to objectively evaluate the outcomes of educational interventions on EBP [3,6]. Many of the outcomes evaluated in the original studies were based on ED nurses' self-assessment. However, self-review is a subjective form of assessment and prone to recall bias because participants may believe their baseline competence to be much poorer than it actually is. Consequently, the improvements observed after an intervention may seem much greater than they actually are [26]. Multiple outcome strategies were used in

most of the original studies. Although patient outcomes were evaluated by auditing patient records or interviewing the patients' parents in some cases, it is important to recall that patient outcomes depend on many variables because actual patient care occurs in complex clinical settings [27].

The data collection intervals were short and none of the included studies had a second or a long-term follow-up. Short intervals between measurements may lead to over-estimation of changes in clinical practice [26,28], and long-term follow-up may be needed to evaluate the persistence of observed outcomes [27,29]. If the interventions had been, for example, repeated staff-education modules, it might have been easier to organize long-term follow-ups and obtain large samples. Clinicians could facilitate such follow-up work by incorporating regular evaluations such as knowledge tests or audits when they plan and implement ongoing staff education on EBP.

The original studies had small samples and mostly involved single institutions. This may have limited their statistical power and generalizability. In addition, the timing of the pre-test data gathering was not precisely reported in one study. None of the studies specified whether pre-test information was used when developing the studied intervention [28]. In all studies, data were collected using a new instrument developed by the researcher or research team, and there was little information on how the instruments were developed and validated. The development of new instruments is understandable because the educational interventions had been focused on clinical issues, and suitable validated and tested instruments may not have existed. There are established instruments with reasonable validity for evaluating EBP behaviors, attitudes, self-efficacy, and skills when teaching EBP steps e.g. [29–31]. However, since the studied interventions did not include the EBP steps, these instruments may have been unusable.

Most of the studied interventions had promising effects on emergency nurses' EBP. However, this finding should be interpreted cautiously. Comparing results from different studies is problematic because of differences in the studied interventions, target groups, settings, data collection tools, and measured outcomes [3,6,26]. Our review primarily included small studies with low response rates, and many of them relied on self-assessed outcomes. Improvements of statistical significance and high statistical significance were observed in four studies each. However, it was impossible to determine which elements of the interventions caused these effects because the interventions included many elements and all but one of the studies was uncontrolled.

4.1. Strengths and limitations

To our knowledge, this review is the first attempt to synthesize the evidence on educational interventions promoting EBP among emergency nurses. The review was strengthened by the use of a systematic and extensive search process that used database directories and was conducted with the assistance of an information specialist. Search terms were chosen to produce a wide range of hits, and papers reporting statistically non-significant results were included to avoid bias. To avoid subjective selection bias, papers were selected for inclusion by two researchers working independently. Relevant information about the original studies was meticulously recorded in a matrix, and careful use of this information in the analysis increased the review's reliability. This review will be useful to emergency nursing clinicians and researchers because all of the included studies relate directly to emergency nursing.

The review may be limited by publication bias because grey literature is difficult to obtain and was not searched for. Language bias is also possible because only papers published in English were included. All but one of the original studies used an uncontrolled quasi-experimental study design. This could be regarded as a weakness of the study designs [25]. It would therefore be desirable for randomized controlled trials to be used in future studies on the promotion of EBP in EDs. These limitations notwithstanding, this review should assist clinicians and

researchers in planning, implementing, and evaluating educational interventions on EBP for emergency nurses.

5. Conclusions

There have been few studies on educational interventions promoting EBP among emergency nurses, but their outcomes are promising. However, the strength of the evidence for these outcomes is modest. This review suggests that face-to-face tutorials and/or self-directed learning packages are effective educational strategies for teaching EBP in EDs. When designing and reporting educational interventions, researchers should use reporting guidelines or frameworks to provide transparent descriptions of what has been done and found. When evaluating the outcomes of educational interventions, all relevant areas of assessment should be addressed. Finally, in future, randomized controlled trials are needed to assess the effects of the educational interventions.

Conflict of interest

None.

Ethical statement

Not applicable.

Funding source

None.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.ienj.2018.06.004>.

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